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ADAPTING STANDARD AND HIGH ANALYSIS FERTILIZERS TO TRUCK SOILS IN SOUTHEASTERN TRUCK CROP BELT

EDITOR'S NOTE:- A bulletin on the subject treated here has just been issued by the North Carolina Agricultural Experiment Station. It gives data from extensive experiments with white potatoes, sweet potatoes, and strawberries and includes a summary of the results of even more extensive experiments with cotton. This bulletin clearly indicates methods of improving fertilizer practice and reducing fertilizer costs. The bulletin may be secured from the Station at Raleigh, North Carolina. The abstract which follows is for the most part quotations from the bulletin.

By J. J. Skinner and R. A. Lineberry,
Bureau of Plant Industry,
U. S. Department of Agriculture,
and
H. B. Mann and E. R. Collins,
N. C. Agricultural Experiment Station.

"Data have been presented (13) relative to adapting standard and high analysis fertilizers for cotton soils of the southeastern cotton belt and some of the essential data secured on North Carolina soils are reviewed in this bulletin. ---These studies lead to the following conclusions regarding cotton fertilizers: (1) Differences in the efficiency of cotton fertilizers are usually due to differences in (a) the content of the secondary fertilizer elements, calcium and magnesium or (b) the acid-forming properties of the fertilizer; (2) In standard strength fertilizers formulated to be neutral, the inorganic* sources of nitrogen were as effective for cotton production as higher priced organic sources; (3) High analysis fertilizers containing only soluble but leaching resistant forms of nitrogen were as efficient as non-acid standard strength fertilizers and were frequently more efficient than acid-forming standard strength fertilizers. This class of fertilizers, as well as standard fertilizers, has given best results when applied to the side of the seed simultaneously with planting in one operation."

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*In this bulletin the term "inorganic sources of nitrogen" is used synonymously with the term "soluble sources of nitrogen." It includes soluble organic materials, such as urea. The term "organic and insoluble sources of nitrogen" refers to natural organic materials, such as cottonseed meal, tankage, and fish scrap.

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"The purpose of this bulletin is to review fertilizer experiments relating to truck fertilizers in order to determine whether or not the factors affecting the efficiency of fertilizers for cotton soils also determine the efficiency of fertilizers for truck soils in the southeastern truck crop belt."

Potato Fertilizer Experiments

Sources of Nitrogen:

The results of a five year experiment on Bladen fine sandy loam are reported.

"The data show a marked difference in the efficiency of different forms of water soluble nitrogen. Sodium nitrate and ammonium sulfate, the former basic but readily leached, the latter highly acidic but fairly leaching resistant, produced relatively low yields. Urea, and ammonium phosphate plus urea, produced relatively good yields, 44 bushels more than sodium nitrate or ammonium sulfate. There was but little difference in the yields produced by various mixtures of organic and inorganic nitrogen. These mixtures produced a slightly higher total yield than did urea and the combination of ammonium phosphate and urea.

"The greatest yields of primes were produced by the urea and the inorganic-organic mixtures. The differences between the various mixtures are not wide, except that the cottonseed meal and sodium nitrate treatment gave a slightly lower yield of primes.

"The data indicate the importance of deriving nitrogen from a source or combination of sources that have a relatively low equivalent acidity and that at the same time are moderately resistant to loss by leaching."

Similar results are reported as having been secured in the Coastal Plain potato belt north of North Carolina as well as in South Carolina.

High Analysis Experiments:

An experiment with acid and neutral standard and high analysis fertilizers was conducted on two soils for a three year period.

"The standard 7-6-5 fertilizer was very acid and produced an average yield of 186 bushels, approximately the same yield as did the (Acid-forming) double strength fertilizer (No. 6) and these were the lowest yields of any of the fertilized plots. Neutralizing the fertilizer with calcitic limestone increased yields on both soils as did an additional supplement of magnesium sulfate to the calcitic limestone on plot 3. The dolomitic limestone supplement used on plot 4 was as efficient as the combination of calcitic limestone and soluble magnesium in the form of magnesium sulfate on plot 3. On plot 5, urea replaced cottonseed meal as a source of one-eighth of the nitrogen without significantly lowering the yields. Fertilizers Nos. 3, 4 and 5, on both soils, produced good and not widely different yields. All were neutral and furnished calcium and magnesium.

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"The data of the experiment indicate that the acidity of the fertilizer and its content of calcium and magnesium are important factors influencing the efficiency of Irish potato fertilizers. In this respect the results are in agreement with those reported for cotton."

Sweet Potato Fertilizer Experiments

The results of a four year experiment on sources of nitrogen in a 4-8-8 fertilizer is summarized as follows:

"A study of the other data shows that there is a good correlation between the acidity of the fertilizer and crop yields, or increases due to fertilizer. The fertilizers made with sodium nitrate and cottonseed meal were slightly basic and produced an average increase of 80 bushels per acre. The fertilizers made with sulfate of ammonia and cottonseed meal were quite acid, increased the acidity of the soil, and produced an average increase of only 61 bushels per acre. The fertilizers made with urea and cottonseed meal were moderately acid and produced an increase of 75 bushels per acre, better than secured with the more acidic ammonium sulfate mixtures but not as good as with the basic sodium nitrate mixtures. This close correlation between yields and soil acidity indicates that acidity is a factor influencing the efficiency of different sources of nitrogen in fertilizer mixtures."

The results of an experiment with high analysis fertilizers indicated that such fertilizers, when formulated to be non-acid and contain adequate amounts of calcium and magnesium, gave as good yields as standard fertilizers.

Strawberry Fertilizer Experiments

The results of several experiments with different sources of nitrogen, standard and high analysis fertilizers, acid and neutral fertilizers are reported in detail. Consideration is also given to minor elements such as manganese, copper, and zinc. In most experiments the viability (per cent dead plants) as well as yields are reported. The results are summarized in the following paragraph.

"The strawberry experiments in most respects confirm the results secured in experiments with cotton, Irish and sweet potatoes. They indicate that differences due to the sources of nitrogen are eliminated when proper precautions are used in neutralizing the fertilizer. As previously indicated a substitution of soluble for insoluble sources of nitrogen results in a saving in the cost of nitrogen to consumers. The experiments show that both standard and double strength fertilizers should be non-acid-forming unless they are used on limed soil. In the strawberry experiments, the acid-forming double strength fertilizers have given good results but it should be noted that none of the experiments were conducted over a long period of time. It is very probable that this class of fertilizer would have failed to produce good results if the plots after three years were reset to strawberries and the experiments continued for a second or third period of three years each. The results secured with strawberries differ somewhat from those secured with potatoes and cotton in that properly formulated double strength fertilizers were definitely superior to single strength fertilizers even though the latter were made non-acid-forming."

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Discussion and Summary

The outstanding results and conclusions drawn from the experiments with the different crops are given. The economic significance of the findings is rather fully discussed. The following quotations indicate the more important points covered in the discussion.

Cotton:

"The sources of nitrogen did not vary widely in their effect on cotton yield when the fertilizer was properly supplemented with limestone or dolomitic limestone. The largest yields were generally secured with concentrated fertilizers containing soluble but relatively leaching-resistant sources of nitrogen supplemented with the limestones."

Irish Potatoes:

"In a series of experiments reported in this bulletin made in the Aurora and Beaufort sections on the principal soil types used for Irish potatoes, the data secured indicate the importance of deriving nitrogen from a source or combination of sources that have a relatively low equivalent acidity and are at the same time not subject to excessive loss by leaching. The data show that concentrated fertilizers gave yields which are comparable to the single strength fertilizers and that it is necessary to neutralize the acidity of fertilizer and supply calcium and magnesium to obtain maximum yields with Irish potatoes. The results of experiments with sweet potatoes on Norfolk loamy fine sand in Currituck County are in agreement with those secured with Irish potatoes."

Strawberries:

"Data secured in experiments in the Chadbourne strawberry section confirm the results secured in experiments with Irish potatoes and sweet potatoes. They indicate there is little or no difference between sources of nitrogen when they are used in non-acid standard fertilizers. Properly formulated concentrated fertilizers were superior to single strength fertilizers even though the latter were made non-acid forming. The results of experiments with sources of nitrogen and high analysis fertilizers with truck crops in general substantiate those secured with cotton."

Economic Importance:

"In this and former papers (13), a great deal of data are presented to show that on acid soils of the State, fertilizers for truck crops and cotton should be formulated neutral or non-acid-forming. When this is done, the data show there are no wide differences between sources of nitrogen. The substitution of soluble for insoluble nitrogen in cotton and truck fertilizers will result in substantial savings to growers, for as pointed out by Ross and Mehring (10,11), this change would result in as much as an 8 per cent reduction to consumers in the cost of plant food in cotton fertilizers.

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"The data of the experiments as a whole indicate that properly formulated double strength fertilizers may be as efficient as single strength fertilizers for truck and cotton soils of the State, resulting in lower cost to growers. It has been pointed out (10,11), that double strength fertilizers, per unit of plant food, cost consumers approximately 20 per cent less than single strength fertilizers. Some of the more concentrated fertilizer materials have appeared on the market only within the past few years, but they have become of common usage. From the data presented it seems that wider use of such high analysis materials is warranted. The feasibility of using very highly concentrated fertilizers generally for truck and cotton crops may be questioned. However, the plant food concentration in fertilizers for these crops could economically be increased to 20 or 25 units per ton, and the fertilizers could still be made non-acid-forming by the inclusion of dolomitic limestone. Bledsoe (1) points out that farmers who buy 20 units per ton fertilizers 4-12-4, instead of a 15 unit fertilizer, 3-9-3, save 12 percent on their fertilizer bills, and one who buys a 25 unit fertilizer, 5-15-5 saves 19.8 percent. This saving is directly in proportion to the cost of the filler necessary to convert a 5-15-5 or a 4-12-4 into a 3-9-3. He points out that each ton of fertilizer must carry charges for bags, labor, tax, freight, etc., which is added to cost to consumer. Lockwood (8) has pointed out that in general the consumer cost for any particular quantity of plant nutrients decreases as concentration increases and that the proportion of the total cost which the consumer pays for manufacture, packages and distribution, decreases rapidly as the concentration increases. It is estimated that increasing the plant food concentration in commercial fertilizers from 15 to 20 or 25 percent produces saving of 17 to 23 percent.

"The data secured in truck and cotton experiments presented in this and former publications indicate that the use of soluble nitrogen and properly supplemented double strength fertilizers should give good results and reduce the cost of crop production. Fertilizer applied in one operation, simultaneous with planting (a desirable practice on some soils) results in saving of labor. Best results have been secured with cotton on sandy loams, fine sandy loams, and clay loams when all the fertilizer was applied at planting to the side of the seed. On sandy soil types and coarse sands, from which fertilizers are readily leached, application of part of the nitrogen as a side-dressing is preferable."

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SUGGESTIONS FOR THE CONTROL OF THE PEA APHID ARE OFFERED BY A COMMITTEE OF ENTOMOLOGISTS

EDITOR'S NOTE:- These suggestions for 1938 were prepared by a committee of entomologists representing a number of the state experiment stations and the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture. (Indianapolis, Indiana, December 27, 1937.)

The following recommendations are based on observations and data accumulated from experimental work done east of the Rocky Mountains.

Satisfactory control of the pea aphid has been accomplished by several methods. These include, without suggestion of preference, (1) dusting, (2) use of nicotine vaporizer, and (3) spraying. Success in the use of any of these methods will depend entirely upon adequate and efficient equipment and properly timed, thorough application.

(1) Dusting with Derris or Cube: Field experiments with derris or cube dust mixtures containing talc or other suitable carriers, conditioned with a liquid spreading and wetting agent, have resulted in satisfactory control. Such dust should contain approximately 1% rotenone.

For information concerning spreading and wetting agents in sprays or dusts consult your Experiment Station Entomologist or the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

In applying these dusts the boom should be completely enclosed and a trailer 25 feet or more in length should be used. Dusts should be applied at the rate of 35 to 40 lbs. per acre. The speed of the machine should not exceed 3 miles per hour or 300 feet per minute. Dusting is much less effective when the wind velocity exceeds 8 to 10 miles per hour.

(2) Nicotine Dusting: For satisfactory results with nicotine dusting, it is necessary to use a trailer 100 feet long, made of gas-proofed material. Boom and nozzles should be entirely enclosed. The dust should contain approximately 4% actual nicotine. The following formula is suggested for those using a self mixing duster; hydrated lime 50 pounds, monohydrated copper sulfate 3 to 5 pounds, 40% nicotine sulfate 2 quarts.

The speed of the machine should not exceed approximately 1 mile per hour, or 100 feet per minute. The trucks used should be equipped with low-speed transmissions so that they can be driven in pea fields at the speeds mentioned.

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Dusting with nicotine is much less effective when the temperature drops below 65 degrees F., or when the vines are wet.

(3) Nicotine Vaporizer: Experimental data and field observations during the last two years show that this method results in a quick and positive kill. In order to obtain effective results a gas-proof trailer 100 feet long must be used, at a machine speed to give an exposure of approximately one minute.

(4) Spraying is an effective method of control but its economic usefulness is conditioned by the nearness of an adequate water supply.

On the basis of ground derris or cube root containing 4% rotenone, 3 pounds should be used per 100 gallons of water. Corresponding dilutions should be used with derris or cube containing more or less than 4% rotenone. A spreading and wetting agent, in either liquid or dry form, is necessary. The application per acre should be from 125 to 200 gallons. Pressure should be 225 to 300 pounds, and depends on size of disc apertures, type of nozzle, and pump capacity.

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It is impossible to forecast the weather conditions that largely determine the rate of increase of the aphid populations and the duration of the period of peak abundance. This makes difficult precise directions in regard to the numbers of aphids that justify beginning treatment. However, a large proportion of unsatisfactory results are traceable directly to delaying treatment until much of the damage has been done. It is believed that an infestation that is reflected by 35 aphids per sweep for an average of 5 sweeps in different parts of the field, with a standard collecting net, is usually an indication that treatment should be begun. Consult your Experiment Station Entomologist for suggestions in regard to sweeping methods.

With any of the above methods for pea aphid control good results cannot be obtained unless the equipment is in good repair and adequate to cover the acreage in 10 days to 2 weeks.

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HEAT AND FORMALDEHYDE FOR SOIL TREATMENT EFFECTIVE EXPERIMENTS IN PENNSYLVANIA BY A NEW METHOD PROVE

EDITOR'S NOTE:- The excerpts given here are from Bulletin 348, "Combining Heat and Formaldehyde for Soil Treatment," The Pennsylvania State College, School of Agriculture and Experiment Station, State College, Pennsylvania. The author is Kenneth G. Beachley. It is important to note that considerable data are omitted, including Tables 1 and 2, and the bibliography. It is suggested that readers obtain a copy of this informative bulletin.

The importance of ridding the soil of various disease-producing organisms, weed seeds, and insects, in the production of healthy seedlings in outdoor seedbeds and greenhouses, has long been recognized. The processes employed to that end usually have been referred to as sterilization or disinfection. While these terms are not accurate, they have been generally used and it is believed that their further use will not result in misunderstanding.

Surface firing was the first means of partial sterilization and in some sections of the country it is still used. In the southern tobacco areas, where wood is plentiful, it is still the common practice. The baking process is a modification of surface firing. Usually the soil is supported by a piece of sheet iron on standards, with a fire beneath.

Chemicals were first used in soil treatment about 1867, when formaldehyde was introduced by the German chemist, Hoffman. Today, many chemicals are effective and satisfactory in some respects but are not so efficient as steam or heat in the control of weeds, fungi, bacteria, nematodes, and insect pests.

Formaldehyde is the chemical most commonly used in soil disinfection. Recommendations for the application of this chemical vary. A common one is to drench the soil with a solution of one part formaldehyde to 50 parts water at the rate of one-half gallon per square foot. It is unsafe to seed for approximately two weeks after this treatment. For treating small quantities of soil, Guterman and Massey (8) found that more concentrated solutions of formaldehyde may be used by mixing it thoroughly with the soil. Formaldehyde dusts -- formaldehyde incorporated with various pulverized materials -- have been advocated as a satisfactory means of controlling damping-off fungi (19). Other chemicals, such as glacial acetic acid (4), carbon bisulphide, mercuric chloride (18), chloropicrin (7), sulphuric acid (9), copper sulphate (9), acetic acid (4), and pyroligneous acid (5), have been used with varying success in soil disinfection. Most of these fungicides have the disadvantage of not being effective in the control of weeds, nematodes, and insect pests.

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Steam was first employed for soil sterilization in 1893 by W. H. Rudd of Greenwood, Illinois. He placed the soil in a box or chamber in which were perforated steam pipes. This method is still used but it requires more handling of the soil than other methods and is not practical for large quantities of soil. A modified method in the use of steam is the buried perforated pipe, or tile system. The pipe or tile is laid 12 to 14 inches deep, and 18 to 20 inches apart in the soil to be treated. The steam then is injected into the soil until the temperature has risen sufficiently high to effect partial sterilization.

The inverted steam pan method was first used by A. D. Shamel, of the United States Department of Agriculture, in 1904 to treat tobacco seedbeds. There are many variations in the construction and size of the pans and in the position of the steam inlet. The soil is covered with an inverted pan and steam is forced underneath it. After steaming is discontinued, the pan may be left in place or the soil covered with burlap or paper to conserve the heat and prevent recontamination. This has been the most efficient and practical method for outdoor seedbeds. The steam rake has been used somewhat but is less effective than either the buried tile or the inverted pan.

Hot water treatment of soil is a satisfactory method for pots or flats, or where small quantities of soil are involved. Pots filled with soil are immersed for five minutes in water at a temperature of 208°F.

Electric heat was found practicable by Newhall and Nixon (17) for the treatment of small quantities of soil.

Treatment of large quantities of soil by the use of chemicals is usually prohibitive because of the high cost. Chemicals have the further disadvantage of inefficient control of weeds and insect pests and, in many cases, considerable delay in seeding after treatment.

Treatment by heat, while effective and relatively inexpensive, has not been used more generally because of lack of convenient equipment. The more general use of gasoline engines and tractors for power has resulted in a scarcity of steam engines in many localities. The South, in particular, has need for an efficient and practical means of soil disinfection for tobacco and vegetable seedbeds.

The study here reported involves a new method of soil treatment, using a combination of heat and a chemical. The principle of operation of this apparatus differs from the steam boiler in that water or chemical solutions are vaporized while being pumped through heated coils. When a volatile chemical, such as formaldehyde, is used in a solution, separation of the chemical by distillation is prevented, and the concentration of the chemical vapor is constant. In a steam boiler these chemicals are distilled off at their respective boiling points.

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Objects of the Experiments

1. To determine whether formaldehyde in combination with steam-vapor would result in greater efficiency of disinfection than steam-vapor alone, and greater depth of penetration of formaldehyde than a drench.
2. To determine the effect of initial moisture content of the soil on the penetration of steam-vapor.
3. To compare the new apparatus with a steam boiler with respect to efficiency and cost.

Effect of Formaldehyde in Combination with Steam Vapor in Killing a Damping-Off Fungus

Anderson and McClintic (2) state: "It is a well-known principle in the use of disinfectants that, within certain limits, the higher the temperature at which the disinfectant is used, the greater its germicidal properties." I. E. Melhus (13) states: "The increase in germicidal properties of disinfectants through the influence of heat is not the same for all disinfectants; some, such as formaldehyde, are more strongly influenced than others."

The only record on the combination of chemicals with steam for the disinfection of soil is the report by Hunt, O'Donnell, and Marshall (10) on eradication of potato wart, Synchytrium endobioticum. They sprinkled the soil with a solution of formaldehyde and then steamed it with an inverted pan. Using Schryver's test, they found that formaldehyde applied in this way did not penetrate the soil more than about one inch. This method was repeated in the experiments here reported, and their results were confirmed.

Formaldehyde is very difficult to volatilize in a water solution. Melhus reports that boiling a 1/200 solution of formaldehyde for 15 minutes resulted in a loss of only .00008 gram per cubic centimeter. In general, the strength of the solution remains approximately the same throughout heating or boiling. This suggests the reason why formaldehyde applied as a drench does not penetrate the soil deeper than the water that carries it.

Methods.--The principle of operation involved makes it possible to combine formaldehyde in widely varying amounts with steam vapor at high temperatures. The formaldehyde was put in the tank with water and the solution vaporized under a vapor pressure of 150 pounds at a temperature of 365.9 degrees Fahrenheit. Samples of soil were taken at 2, 4, 6, 8, 10, and 12 inches deep, and formaldehyde penetration determined by the use of Schryver's test.

The effectiveness of formaldehyde applied in combination with the steam-vapor was determined by the following method. An undetermined species of Fusarium, isolated from an infected dianthus seedling and grown in pure culture, was transferred to steam-sterilized rye and allowed to grow on this medium until it was well established. This fungus was selected because it grows rapidly and has a characteristic type of growth on corn meal agar. Five to six of the rye grains, overgrown with the fungus, were placed in 25 by 15 mm. specimen vials from which the bottoms had been broken. Both ends were plugged with loose cotton

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wool to permit free movement of vapor through the vials. The vials were tied in cheesecloth bags and placed at depths of 4, 6, 8, 10, and 12 inches in cylindrical containers or cans (Fig.3). The cans were placed in the ground, level with the soil. The length of treatment and the strength of the formaldehyde were varied in such a manner as to apply formaldehyde at the rate of 8, 12, and 16 ounces per 100 square feet. These amounts are 1/16, 1/10.6, and 1/8 of the quantity commonly recommended for drenching soil, which is 8 pounds to 100 square feet.

When the ground had cooled, 16 to 24 hours after treatment, the vials were removed to the laboratory and the grains transferred to petri dishes on corn meal agar. At the end of 48 hours, growth of the Fusarium on the plates was recorded.

Results.--The results of using a combination of formaldehyde and steam vapor in comparison with steam-vapor alone, as measured by the killing of a Fusarium, are recorded in Table 1. There was consistently a greater depth of kill where formaldehyde was added. The average depth of kill for the 10-minute period of disinfection, where 8 ounces of formaldehyde per 100 square feet had been used, was one inch, as compared with no kill where steam-vapor alone had been used.

In the 15-minute period, formaldehyde solution vapor, at a dilution that would deliver 8 ounces per 100 square feet was effective two inches deeper than steam-vapor alone. The Fusarium was killed at an average depth of six inches, while formaldehyde penetrated to an average depth of seven inches. With steam-vapor alone, killing took place to an average depth of only four inches.

In the 20-minute periods, two concentrations of formaldehyde solution were used, one applying 8 ounces of formaldehyde and the other 16 ounces per 100 square feet. With eight ounces, killing resulted up to a depth of 7.6 inches, and the presence of formaldehyde was indicated by a positive test at an average depth of 8.2 inches. For the same period steam-vapor alone killed to an average depth of 5.2 inches, or a difference in the depth of kill of 2.4 inches. When 16 ounces were used, there was a difference in depth of kill of three inches in favor of formaldehyde vapor, but the depth of kill was not so deep as where eight ounces were used, since treatment was made somewhat later in the fall, when the soil was cold and wet.

The 25 and 30-minute periods of treatment resulted in disinfection to a depth of 8 inches in both cases. There was little if any increase in depth of kill resulting from the addition of formaldehyde.

These results indicate that with the inverted pan method disinfection cannot be expected to a greater depth than 8 or 10 inches in this soil type--Hagerstown silt loam. In sandy soil, disinfection may be expected to a greater depth. These results are in accord with those obtained by other investigators.

Table 1 shows a correlation between formaldehyde penetration and depth of kill of the Fusarium. In every case where formaldehyde solution vapor was used, the soil samples gave a positive test for the chemical at the same depth or several

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inches deeper than that at which the organisms were killed. It is apparent from the difference in the depth of the kill of this fungus that small quantities of formaldehyde (8 to 16 ounces per 100 square feet) added to the water are more effective than steam-vapor alone.

When the soil was drenched with formaldehyde at the rate of 8 ounces to 100 square feet in a dilution that would give one pint of solution to the square foot, and followed by steaming for 20 minutes, the samples gave a positive test for formaldehyde to an average depth of only three inches. This was the depth to which the solution had percolated. Hunt, O'Donnell and Marshall (10), using the same method, found that formaldehyde penetrated from 1 to 4 inches. When the soil was treated with this same quantity of formaldehyde in the form of vapor for 20 minutes, the average penetration in 10 tests was 8.2 inches; in all cases it was at least 6 inches. This shows that formaldehyde, applied as a vapor, can be driven into the soil as deep as steam-vapor (Table 2).

Discussion.--In all the experiments in which the combination of formaldehyde and steam-vapor was compared with steam-vapor alone for killing the Fusarium, the former treatment gave significantly greater depth of kill than did the latter. The addition of formaldehyde gave the greatest benefit in the shorter periods of treatment (15 minutes) and for soil which was too wet for good steaming. The addition of formaldehyde was less advantageous in the 30-minute period of treatment and for soil which was sufficiently dry for good penetration of steam. In a heavy Hagerstown silt loam, formaldehyde could not be driven beyond a depth of 10 inches. This is a depth to which disinfection is possible with steam alone under favorable conditions for steaming.

The difference in depth of kill of the Fusarium indicates that addition of formaldehyde in small quantities, driven into the soil as a vapor, is effective in disinfection. Tests for this chemical showed that it had penetrated as far as or beyond the depth at which the organism was killed. Checks indicated that heat alone was not responsible for killing at this depth.

Formaldehyde vapor can be driven into the soil as deeply as steam, the depth depending on the type and condition of the soil. When it is sprinkled on the soil in solution and the soil then steamed, it will not penetrate to a depth greater than the solution carrying it.

The apparatus used in this experiment is the first equipment available that makes it possible to combine formaldehyde and steam-vapor for soil disinfection. Because of this feature it has an advantage over the steam boiler when it is desirable to shorten the period of treatment or to disinfect soil under adverse conditions.

Treatment of Seed Flats under an Inverted Pan With Steam Vapor and Formaldehyde

Greenhouse flats were treated and planted with vegetable, flower, and tobacco seeds preliminary to the disinfection of outdoor seedbeds. Flats were treated with steam-vapor, alone and in combination with formaldehyde vapor. Flats were also treated in a steam box for 90 minutes at 10 to 12 pounds pressure,

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for comparison with those treated by the steam-vapor method. A total of 63 flats was disinfected and seeded, including the checks. The details of these preliminary tests are not presented here, but the results are of interest. The application to flats of .097 ounce of formaldehyde per square foot as a vapor in 15-minute periods protected seedlings against damping-off during and after seed germination just as well as the steam box method for 90 minutes. When soils were treated with formaldehyde in combination with steam-vapor, it was possible to plant most vegetable, flower, and tobacco seeds 24 hours after treatment. Treating seed flats with small amounts of formaldehyde vapor, reduced the need of seed disinfection before planting.

Sterilization of Tobacco Seedbeds

Method.--In the tobacco experiment plots in Lancaster county, Pennsylvania, a comparison was made between seedbeds steamed with a 16 horsepower steam boiler for 30 minutes, and those treated by the steam-vapor generator for 20 or 30-minute periods, using 32, 16, 8 and 4 ounces of formaldehyde per 100 square feet. All the beds were seeded approximately 24 hours after treatment. Counts were made of tobacco seedlings on a representative area, 10 by 10 inches, 30 days after treatment. Records were kept of the quantity of fuel oil and gasoline used and actual operating costs were computed.

Results.--There appeared to be no significant difference resulting from the several methods of treatment. There was the usual great difference between the untreated checks and the disinfected beds, as far as acceleration of growth, control of weeds, and general appearance of the plants were concerned. In most cases, the weeds completely crowded out the tobacco plants on untreated soil. At transplanting, no significant difference could be noticed in the growth of the plants among the plots receiving the various vapor treatments. There was no formaldehyde injury in the seedbeds like that in seed flats treated with comparable amounts of formaldehyde for 15 minutes. There was no damping-off of the seedlings. In practically all cases the plants pulled from beds disinfected with the steam-vapor were as large and as healthy as those from beds treated with the steam boiler.

Cost.-- A record was kept of fuel consumed in the disinfection of approximately 1000 square feet of tobacco seedbeds.

Cost per hour of operation:

Fuel oil, 3.5 gallons per hour @ $.065	$.2275
Gasoline, 1/6 gallon per hour @ $.18	.03
Labor for operating @ $.40 per hour	.40
Total	$.6575

This figure does not include the cost of the apparatus, or the cost of the water used. The size of the pan used in this experiment was 33 square feet. The treatments were for 30-minute periods, when steam-vapor alone was used. Thus the cost of operation was approximately one cent per square foot.

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When formaldehyde was combined with steam-vapor and applied at the rate of 16 ounces per 100 square feet, the treatment could be shortened to 20 minutes with as satisfactory results as steam-vapor alone for 30 minutes. Using commercial formaldehyde at 15 cents per pound, and shortening the treatment to 20 minutes, the cost was reduced to approximately 80 cents per 100 square feet, compared with $1 per 100 square feet with steam-vapor alone.

The cost of disinfecting soil with this equipment is within the range of that reported by other investigators. Beinhart (3) reports that the charge for steaming varies in tobacco-growing sections from 50 cents to $1 per 100 square feet, or from $6 to $12 per day. The contractors may or may not furnish the pan and fuel. Newhall (14) gives the cost of steaming by the pan method as $.006 to $.012 per square foot. Hunt, O'Donnell, and Marshall (10) report the cost as approximately $15 per day. This would average about $.046 per square foot when steamed for 90 minutes, or $1.52 per 100 square feet when steamed for 30 minutes.

The average cost of steaming tobacco seedbeds with a steam engine for 30 minutes in Lancaster county in the spring of 1935, was $1.30 per 100 square feet.

Discussion.-- Comparing the results obtained from treating seedbeds and seed-flats, it is evident that the principle of the apparatus used offers an efficient and relatively inexpensive means of soil disinfection.

Other advantages of this type of equipment for soil disinfection are its low initial cost, its compactness and portability as compared with the traction steam boiler and its adaptability for other uses. The machine may be obtained with a greater capacity than the one used in this experiment.

Summary

This investigation was concerned with the efficiency of an apparatus which combines heat and chemical treatments as a means of soil disinfection.

1. Formaldehyde in combination with steam-vapor as applied with this apparatus made it possible to shorten the period of soil treatment with the inverted pan and increase the efficiency of this method in disinfecting cold and wet soils.

2. Vaporized formaldehyde was driven into the soil as deeply as steam, while the same amount of formaldehyde applied as a drench penetrated only as deep as the water carrying it.

3. By combining as small a quantity of formaldehyde as one pound per 100 square feet with steam-vapor, a 20-minute treatment was as effective in the disinfection of seed beds as a 30-minute treatment with steam-vapor alone.

4. The initial moisture content of soil is a limiting factor in the penetration of steam-vapor. In Hagerstown silt loam, disinfection to a 6-inch depth resulted with 30 minutes steaming in soil containing not more than 15 per cent moisture.

5. The application to seed-flats of .097 ounce of formaldehyde per square foot as a vapor in 15-minute periods, protected seedlings against damping-off during

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and after seed germination as well as the steam box method for 90 minutes, and also reduced the need for seed treatment.

6. When soil was treated with formaldehyde in combination with steam-vapor it was possible to plant most vegetable and flower seeds 24 hours after treatment.

7. Treating tobacco seedbeds with steam vapor, alone or in combination with formaldehyde, gave as satisfactory results as those treated with the steam engine.

8. The cost of disinfecting seedbeds, using steam-vapor alone for 30 minutes, was approximately $1 per 100 square feet.

9. By combining one pound of formaldehyde per 100 square feet with the steam-vapor and shortening the period of treatment to 20 minutes, the cost was reduced to approximately 80 cents per 100 square feet.

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THIRD ANNUAL NORTH AMERICAN WILDLIFE CONFERENCE TO DISCUSS MANY IMPORTANT PROBLEMS AT BALTIMORE

EDITOR'S NOTE:-It is now accepted that vital problems of wildlife conservation and some of those of agriculture are closely related. Because of this, the proceedings of the forthcoming wildlife conference will be followed with interest by many readers of this publication.

Dramatic presentations will be made of the latest research developments and important problems in the field of wildlife restoration at the Third Annual North American Wildlife Conference, to be held in Baltimore, Maryland, February 14, 15, 16 and 17.

Controversial subjects will be treated at the general sessions. Each perplexing problem will be subjected to a panel discussion, with four authorities arguing the pros and cons. The authorities are now being selected by the American Wildlife Institute, the sponsoring organization for the Conference.

Each of the four authorities will be allowed ten minutes to air his views and an opportunity will be granted for rebuttal. The remainder of the hour's time will be allowed each subject under discussion at the general sessions and will be devoted to open comment from the floor.

Eighteen subjects of wide interest will be subjected to the panel discussions at the general sessions. Among the subjects to be so treated are pollution, drainage and reclamation, mosquito control, waterfowl and fisheries problems.

Sixty Papers on Technical Subjects

Sixty papers are now being chosen from among the hundreds submitted for presentation at the technical sessions. The selections are being made by a committee appointed by the Wildlife Society, which at the request of the American Wildlife Institute, is arranging the technical program. This committee is composed of Ernest Holt, Chief of the Division of Wildlife Management, Soil Conservation Service, chairman of the Committee; W. L. McAtee, Special Technical Advisor of the Bureau of Biological Survey, and V. H. Cahalane, in Charge of Wildlife, Natural Park Service. The Conference program committee is headed by C. M. Palmer, Jr., Assistant Secretary of the American Wildlife Institute.

There will be two technical sessions running concurrently each day of the Conference except February 17, which will be given over to the national convention of the General Wildlife Federation. Five papers will be presented each day at each of the concurrent technical sessions.

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During the day dedicated to the national convention of the General Wildlife Federation, attention will be focused on plans for North American Wildlife Restoration Week, beginning March 20.

During the week the Conference is being held in Baltimore, the Oriole City will also be the site of the North American Sports, Garden and Outdoor Life Show, a civic enterprise of particular interest to outdoorsmen.

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DITCHES AND CHANNELS OF INCREASINGLY LARGE SIZE EXCAVATED BY VARIOUS METHODS OF USING DYNAMITE

EDITOR'S NOTE:- Blasting channels with dynamite has proved of value in flood control and for various other purposes where speed in doing the work was a factor or it was not practicable to move machinery to the sites because of transportation difficulties. Dynamite, it is to be noted, can be taken anywhere a man can go. That explosives experts are now able to blast larger and larger channels is a fact of which many are unaware.

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The question has often been asked how large a ditch or channel can be blasted with dynamite. The most honest answer to this is we do not know. The statement has frequently been made that if you use enough dynamite, you can move anything. This may be true, but sometimes the material will not stay moved. In other words, you could place several tons of dynamite in water -- blow the water away, and it would return. This would also be true of very oozy mud or quicksand.

In the past several years, there have been a number of very large channels blasted, completely, with explosives. A recent piece of work was done in Pennsylvania, where a single line of holes was used to make a channel 20 feet deep and 60 feet wide at the top, with a 20-foot bottom width. The amount of dynamite per hole was based on one pound per cubic yard. Material moved was a wet clay type of soil.

A channel in New York State was blasted 70 feet wide and nine feet deep in a muck type of soil. There was a sandy soil below the muck which gave an exceedingly good shooting bottom. This blasting was done by the cross-section method, based on 1-1/4 pounds of dynamite per cubic yard.

Channel of Exceptional Width in South America

In South America, a channel was made 80 feet to 120 feet wide and from six feet to 15 feet deep in a clay type of soil, which was extremely wet. A combination of the relief and the cross-section methods of loading was followed. Due to the great width desired, it was necessary to use an additional quantity of dynamite to throw clear this material, so the basis of loading was 1-3/4 pounds per cubic yard.

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Recently, in Canada, a channel was blasted nine feet deep, with a 65-foot top width and a 30-foot bottom. In this case, there were six feet of muck over wet clay. This was blasted with a single line of holes, and the loading was based on one pound per cubic yard.

In connection with the examples described, it is important to note that where the desired size of channel can be obtained with a single line of holes, the maximum can be expected from the dynamite, and, in general, the rule of thumb -- one pound per cubic yard -- can be adhered to.

It is agreed that where a ditch or channel can be made with a single line of holes, the blasting condition is ideal. Such loading may start with a half pound of Ditching Dynamite per hole, and go to as much as 150 pounds per hole. The general practice is to column load half-pound sticks up to five or six sticks per hole. Loads larger than that are usually bundle or large-cartridge loads, exploded in holes six to eight inches in diameter, which are made by means of a post hole digger. On some of the work mentioned, cartridges as large as five inches in diameter and 24 inches long were used. These run three (3) to the 50-pound case.

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